Chapter 7
Geospatial Data Overview and Standards

7-1. General

CADD and GIS are means to an end, rather than ends in and of themselves. That is, the technology helps users to perform a variety of tasks, but it does not satisfy any USACE mission objectives by virtue of its existence. Therefore, USACE has not mandated any particular CADD or GIS hardware or software platforms. Rather, USACE has focused on standardizing data and data life-cycle management to meet the many challenges today and tomorrow. This focus on standards and life-cycle management enables interoperability and provides an effective tool for USACE to manage the investments made in CADD and GIS technologies. The cost of developing and maintaining geospatial data is the most expensive and crucial part of implementing geospatial strategies. Standardization will enable the data collected by District or field offices to be used throughout the organization in an Enterprise implementation. In addition, strict adherence to Federal, national, and international standards will extend their usefulness to local, State, national, and international agencies. Strict compliance will also ensure that the data these other agencies collect will be compatible and interchangeable with USACE data sets.

7-2. Importance of Geospatial and Data Standards (GD&S)

The development of GD&S is adaptive and flexible in meeting the technological advances of today, the speed and accuracy of analyses, and the ongoing output of designs and displays. GD&S make possible the processing of greater volumes of shared data, and they enable a much larger audience to interpret and understand the data, whether for geospatial or other uses. To keep GD&S current and relevant requires regular refreshing in anticipation of emerging technologies. The maturation of geospatial technologies has resulted in the potential for wide use by many organizations. Standards, therefore, provide the interoperability and flexibility that allow users to adapt them to their specific environments.

a. Benefits of GD&S. The adoption of standards provides a multitude of benefits, such as the following:

- *Removal of barriers* – Standards enhance geospatial data exchange and sharing. The exchange mechanisms for the transfer of geospatial data between dissimilar systems are addressed by standards.

- *Improvement in data quality and configuration management* – Standards provide metadata to help organize and maintain the organization's internal spatial data.

- *Increased user confidence* – Standards provide confidence in the quality of the data, and they define data structure and content.

- *Greater access to geospatial data* – Standards widen the spectrum of available data that results in a broad range of choices available to the user community.

- *Integration of systems* – Standards enable the use of data across a wide spectrum of applications, thus maximizing effective use of systems.

- *Data collection* – Standards reduce duplication and overall costs of geospatial data collections.

- *Greater public access* – Standards extend the use of geospatial data in the public sector, resulting in an increase in the GD&S-user base due to data availability with an attendant diffusion of knowledge.

b. Types of geospatial data standards.

(1) Standards may be catalogued in several ways. Usually they are developed in either an informal or formal process, in reaction to or in anticipation of need. An informal process is developed by source of authority. An informal standard, or de facto standard, is exemplified by AutoCAD DXF. This is when the user community, through constant use, adopts a practice without any formal certification. A formal process for developing a standard requires certification by a government body or a professional organization. Types of geospatial data standards include the following:

- *Data modeling* – Either a conceptual or logical description of data organization.
- *Data content* – A definition of feature, attribute, and values.
- *Data symbology* – Specifies display and output symbol libraries.
- *Data quality reporting* – Provides a standard for data set quality reporting.
- *Metadata* – Data that describes the data set and includes information on its usage.
- *Data exchange and transfer* – Standards that define how data are exchanged or converted from one format to another.

(2) A number of organizations are involved with the formal process of developing standards. Many but not all of these organizations are given in Table 7-1 below.

Table 7-1
Organizations with Formal Process of Developing Standards

Level	Organization	Web Site
International	International Organization for Standardization (ISO)	www.iso.ch/iso/en/ISOOnline.frontpage
	ISO Technical Committee for Geographic Information/Geomatics (TC211)	www.isotc211.org/
	Open GIS Consortium	www.opengis.org/
	International Committee for Information Technology Standards (INCITS)	www.incits.org/geninfo.htm
	International Hydrographic Organization (IHO)	http://www.iho.shom.fr/iho.html
	Digital Geographic Information Working Group (DGIWG)	www.digest.org/About2.htm
National	American National Standards Institute (ANSI)	www.ansi.org/default.asp
	National Committee for Information Technology Standards (NCITS L1) Geographic Information Systems	www.ncits.org/tc_home/l1.htm
Federal	Federal Geographic Data Committee (FGDC)	www.fgdc.gov/index.html
	FGDC Standards Working Group	www.fgdc.gov/standards/organization/swg_organization.html
	CADD/GIS Technology Center	www.tsc.wes.army.mil/

(3) Another type of cataloged standards is based on the functionality that each addresses. This type is used in the area of Geospatial Data and Systems (GD&S) and is shown below:

- *Hardware and physical connection standards* – Pertain to the physical connection and cabling of hardware devices.

- *Application standards* – Impact the actual presentation and display of data in a GD&S, such as map design criteria.

- *Software standards* – Address the development of software and software documentation including macros.

- *Professional standards* – Establish levels of competency and training.

- *Network communication standards* – Address the protocols for the transfer of data and information from one computer system to another.

- *Data standards* – Address geospatial data transfer formats, accuracy, documentation, structure, content, and management. Note that these standards are further discussed in paragraph 7.3 below.

7-3. Geospatial Data Components and Applicable Standards

a. It is not the intent to describe in detail geospatial data. There are numerous books and published reference materials on geospatial data. It is the intent of this paragraph to describe geospatial data and identify applicable standards.

b. An entity or feature is a real-world phenomenon, such as a lake, river, house, etc. It can be modeled as a point, polygon, line, raster; but it is the thing being described. Entities, features, and geospatial data in general can be broken into three parts: the spatial component, the attribute component, and the metadata.

(1) *Spatial component.* All geospatial data has a spatial component or locational information associated with it. Locational information can take the form of latitude/longitude, State Plane coordinates, universal transverse Mercator coordinates, etc.; but in order for it to be integrated with other data sets, it must have locational information tied to a geographic system. Traditionally, survey data have been tied to local coordinates rather than a geographic reference system. CADD drawings for architectural, structural, mechanical, and electrical disciplines have not been tied to a geographic coordinate system. CADD civil/site layout drawings are traditionally tied to a State Plane Coordinate System. In order for CADD and survey data to be used in a GIS and an eGIS solution, the data need to be referenced to a geographic coordinate system. Appendix G addresses the technical aspects of georeferencing CADD data. Because today's software enables relatively easy conversion from one geographic coordinate system to another, it is not essential that eGIS efforts at the Districts all use the same geographic reference system; however, it is a good idea to identify a predominant reference system to which most data will adhere.

(a) *Datums*. To register and integrate different data sets, the data sets need to be on the same datum and coordinate system. North American Horizontal Datum 1983 (NAD83) and North American Vertical Datum 1988 (NAVD88) are the preferred datums for collecting geospatial data in USACE. The National Geodetic Survey (NGS) maintains NAD83 and NAVD88, and most State and Federal field offices have moved geospatial data collections to these datums. If other datums are being used, be aware that it will be difficult to integrate local data with regional or national efforts and NGS does not maintain older datums.

(b) *Scale and resolution issues*. The scale of digital data can be manipulated easily; however, the scale should not be made larger than the collection scale. For example, digital data generated from a 1:20,000 base should not be used for large-scale analysis. Increasing the scale/resolution of the collection scale and using it for analysis introduces spatial error into the analysis.

(c) *Spatial accuracy.* Spatial or positional accuracy refers to the accuracy of the location information. Horizontal accuracy is an estimate of the x-, y-positions of spatial objects. For example, "95 percent of the well locations are within 50 meters of their surveyed locations." Vertical accuracy is an estimate of the z-positions of the spatial readings. For example, "95 percent of the elevation points are within ± 1 meter." Most accuracy standards dealing with digital geospatial data have evolved from hardcopy map accuracy standards or photogrammetric standards and are being applied to digital data. The FGDC has endorsed the Geospatial Positioning Accuracy Standard, which consists of five parts. Part 3, "National Standard for Spatial Data Accuracy," and Part 4, "Standards for A/E/C and Facility Management," are directly related to USACE geospatial databases. Part 3 addresses accuracy of data smaller than 1:20,000, and Part 4 addresses accuracy of data larger than 1:20,000. In addition to Parts 3 and 4, Chapter 2 of the Photogrammetric Manual, EM 1110-1-1000, and Chapter 3 of the Hydrographic Surveying Manual, EM 1110-2-1003, outline USACE accuracy requirements.

(2) *Attribute component.* The attribute component, or the nongraphical component of the geospatial data, is the information about the geographic phenomena. For example, the information associated with a lake, such as the name of the lake, volume, discharge rate, etc., are all attribute information. Without the attribute information, the ability to perform spatial analysis is limited to automated mapping.

(a) Developing a database schema (database entity/attribute structure) is a continual process. The more data that are geospatially referenced and integrated into a GIS, the more data are seen as needing to be GIS-enabled. In an attempt to manage these data corporately and alleviate the expense of each District or functional area developing their own database schema, USACE has developed (through the CADD/GIS Center for Facilities Infrastructure and Environment) the SDSFIE.

(b) The SDSFIE is a set of data standards that defines the content of the database. It is endorsed by the American National Standards Institute and is an implementation of the FGDC content standards. The SDSFIE is a physical model and works with Environmental Systems Research Institute and Intergraph products. They provide a structure of the data model as well as mechanisms to transfer the data from one system to another. The SDSFIE is critical in developing the eGIS at District and project offices.

(c) The SDSFIE is most useful when used with an external database, such as Oracle, Informix, or Access. If the Command has not implemented an external database structure, the SDSFIE should be used as a data dictionary. SDSFIE compliance is described in Appendix F. The SDSFIE is updated annually with comments from users and with new information from other standards organizations. Tools are provided with each release to upgrade user databases. The SDSFIE and tools can be downloaded from https://tsc.wes.army.mil/.

(3) *Metadata component.* Geospatial metadata refers to the documentation of geospatial data sets. Geospatial metadata describes the content, quality, condition, and other characteristics of data.

(a) *Types of metadata.* Geospatial metadata can be divided into three categories.

- *FGDC metadata*. The Content Standard for Digital Geospatial Metadata (version 2.0) (FGDC 1998a) or FGDC Metadata is the complete documentation of a data set to enable the data to be used and reused. Documenting geospatial data with FGDC Metadata is a requirement of EO 12906, and

USACE is questioned about metadata production during OMB budget processes. See Chapter 8 for details on documenting data sets with FGDC metadata. General references to metadata in this manual imply FGDC metadata.

- *Management metadata*. Management metadata refers to a core set of elements for cataloging geospatial data. Numerous COTS software packages/modules address managing geospatial data. Management metadata are required by these COTS software to effectively and efficiently catalog and manage geospatial data within an organization. At this time, there are no mandatory or required standards for management of metadata. Some users have implemented the Dublin Core Metadata accessed at http://dublincore.org for management purposes.

- *Feature-level metadata*. Feature-level metadata refers to collection information about an individual feature or object. Feature-level metadata enables data sets to be merged without losing important collection information. For example, collection characteristics (such as collection date) associated with hydrographic soundings are critical information, and the association with the sounding needs to be kept intact when merging it with other data sets. No mandatory feature-level metadata standards exist at this time; however, the Inland Electronic Navigation Chart program will be establishing/identifying mandatory feature-level metadata for hydrographic surveying.

(b) *FGDC metadata resolution*. Metadata resolution refers to the amount of metadata files that are needed to describe a data set. No standard rules exist for how much metadata is needed to define data. Metadata resolution is driven by the data set. A data set of aerial photography may require only one metadata file to define it adequately. If the photography was flown over multiple geographic areas at different times, multiple metadata files are probably required to adequately describe the data set.

(c) *Benefits of metadata.* The benefits of metadata are as follows:

- Organizes and maintains an organization's internal investment in spatial data.

- Enables the reuse of data.

- Provides information about an organization's data holding to data catalogues, clearinghouses, and brokerages.

- Provides information to process and interpret data received through transfer from an external source.

7-4. Authority for Geospatial Data Standards

Standards for geospatial data in USACE are governed by the following organizations.

a. International Committee for Information Technology Standards (INCITS). The INCITS mission is to produce market-driven, voluntary-consensus standards in the area of IT. The work of INCITS L1 Committee consists of adopting or adapting IT standards and developing digital geographic data standards. INCITS L1 technical committee is the U.S. Technical Advisory Group (TAG) to /TC 211, which is the International Standards Organization (ISO) committee chartered to develop international geospatial data standards. ERDC represents USACE on this committee.

b. Open GIS Consortium (OGC). OGC is an international industry consortium of more than 220 companies, government agencies, and universities participating in a consensus process to develop

publicly available geoprocessing specifications. Open interfaces and protocols defined by OpenGIS® Specifications support interoperable solutions that "geo-enable" the Web, wireless, and location-based services, and mainstream IT. They also empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications. ERDC represents USACE in OGC.

c. Federal Geographic Data Committee (FGDC).

(1) OMB Circular A-16, Coordination of Geographic Information and Related Spatial Data Activities, establishes a process to foster the development of a national spatial data framework for an information-based society. Federal, State, and local governments and the private sector provide participation to reduce duplication of effort. Federal agency responsibilities in the coordination of surveying, mapping, and related spatial data are addressed. Established in support of the process is the FGDC. The objective of the FGDC is to promote the coordinated development, use, sharing, and dissemination of surveying, mapping, and related geospatial data.

(2) Per EO 12906, Coordinating Geographic Data Acquisition and Access, the NSDI states, among other things, that Federal agencies collecting or producing geospatial data shall ensure that data will be collected in a manner that meets all relevant standards adopted through the FGDC process. It also establishes FGDC authority over the NSDI and the National Geospatial Data Clearinghouse.

d. The CADD/GIS Technology Center for Facilities, Infrastructure, and the Environment. The CADD/GIS Technology Center is a multiservice vehicle to set standards and coordinate facilities within the Department of Defense. The CADD/GIS Technology Center organization (Board of Directors, Corporate Staff, Field Working Groups, Staff) makes up the FGDC Facilities Working Group. The CADD/GIS Center develops and maintains the SDSFIE, the Architect/Engineering/Construction (AEC) CADD Standards, and the Facility Management Standards. The SDSFIE is the basis for National Committee for Information Technology Standards (NCITS) 353, and the annual release of the SDSFIE is coordinated with the NCITS 353 annual update.

7-5. Mandatory Standards

Standardizing geospatial data impacts the entire USACE organization. HQUSACE mandates only geospatial data standards that are mandated by a higher authority, are sufficiently mature, and will benefit the overall organization. ER 1110-1-8156, chapter 6, requires that persons who believe mandated standards are inappropriate for their use must apply to CECW-EE for a waiver. The waiver must explain why the standards are inappropriate and what will be used instead. Recommended standards are those where compliance is encouraged; however, the maturity of a standard is not sufficient for it to be mandatory. Below are the mandatory geospatial data standards to be used in USACE.

a. Content standards for digital geospatial metadata.

(1) These standards specify the information content of metadata for a set of digital geospatial data. The purpose of the standards is to provide a common set of terminology and definitions for concepts related to these metadata. The data documentation standard, referenced in EO 12906, mandates the documentation of all new geospatial data starting 11 January 1995 and the development of a plan to document geospatial data previously collected or produced by 11 April 1995.

(2) The metadata standard is the product of the FGDC. EO 12906 instructs Federal agencies to use the metadata standard to document new geospatial data beginning in 1995 and to provide these metadata to the public through the National Geospatial Data Clearinghouse. Numerous tools are available (commercial, in the

public domain, and associated with specific vendor products) to generate metadata. The FGDC keeps a list of those available on the Internet at http://www.fgdc.gov/metadata/metatool.html. CorpsMet is a metadata generation tool developed by USACE. It is available at http://corpsgeo1.usace.army.mil/. Under no circumstances should metadata be generated using a word processing software or text package. Metadata must be generated using only a metadata-generation software tool.

b. Spatial Data Standard for Facilities, Infrastructure, and Environment (SDSFIE). The SDSFIE standards are applicable to all Department of Defense activities having civil works or public works, military programs, and environmental programs, or that are responsible for facilities/installation management that do not use a raster model. The SDSFIE prescribes specifications for GIS vector and object-modeled data. The intent is to satisfy the project life-cycle concept for digital data. Many subcommittees and working groups of the FGDC are working to develop content standards, and the work is at various levels of maturity. The final versions of these standards are to be incorporated into the SDSFIE for distribution and use throughout USACE. Therefore, by using the most recent version of the SDSFIE, one will also be using the most recent FGDC content standards.

7-6. Data Policies and Coordination

a. Policies. Each USACE Command may develop tailored GD&S policies to supplement and implement this guidance document. Tailored policies regarding GD&S technologies shall be drafted by the eGIS PDT and approved by the Command's senior leaders. Tailored policies shall adhere to the requirements of this document and all applicable standards, orders, and OMB circulars, and they shall support the goals of the NSDI.

b. Coordination of GD&S efforts. Coordination and prioritization of geospatial data acquisition and GD&S development efforts within a USACE Command shall be the function of the eGIS PDT.

c. Coordination with authorities. The Command's GeoPMT shall appoint a representative to coordinate USACE geospatial data acquisition and GD&S development efforts with local and State governments and national GIS coordinating committees. This representative may be the Command Geospatial Manager or another member of the eGIS PDT. If it is necessary, multiple members of this committee can liaise outside of the Command; however, information exchange then becomes critical. The purpose of the coordination is to reduce duplicative data collection efforts and identify cost-sharing opportunities.

7-7. Required Elements

a. All geospatial data shall be documented using the FGDC or ISO Metadata Content Standard (see paragraph 7-5*a*).

b. All nonraster geospatial data shall be structured using the SDSFIE (see paragraph 7-5*b*).

c. All CADD data collection shall use the AEC CADD Standards (see paragraph 7-4*d*).